

PATENT APPLICATION

Attorney Docket No. P02221US (98425.1P)

TITLE OF THE INVENTION

"Vortex Induced Vibration Suppression Device and Method"

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CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of U.S. Serial Number
10/292,894, filed November 12, 2002, which is a continuation
10 of U.S. Patent Application Serial No. 09/712,759, filed
November 14, 2000 (now abandoned), all hereby incorporated
herein by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR
DEVELOPMENT

15 Not applicable

REFERENCE TO A "MICROFICHE APPENDIX"

Not applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

20 The present invention relates to vortex induced vibration
suppression and more particularly to an improved apparatus for
suppressing vortex induced vibrations in vertical risers of
oil and gas well drilling platforms and production platforms.
Even more particularly, the present invention relates to an
25 improved vortex induced vibration suppression apparatus, also
known as a strake, wherein the improved apparatus includes an
elongated body of flexible polymeric material such as
polyurethane, the body having a wall surrounding a continuous
open-ended bore, a plurality of helical vanes provided on the
30 body, (preferably integral therewith) that extend along the
length of the body and a longitudinal slot that extends
through the wall enabling the body to be separated such as
during placement upon a pipe, riser or pipeline.

2. General Background of the Invention

Vortex induced vibration suppressors are devices that have been used commercially to prevent vortex induced vibration. It has been stated that risers such as those
5 associated with TLP type platforms suffer from vortex induced vibration or "VIV". Floatable and tension leg platform (TLP) risers suffer from vibration induced vortex caused by ocean currents, for example. VIV can be an acute problem in deep water drilling operations. As the current flows around an
10 unsupported pipe such as a pipeline riser, it creates vortices on the leeward side of the pipe. Vortices produce minute pressure fluctuations that create vibrations on the leeward side of the pipe. When these vortices break away from the pipe, they set up vibrations which will dynamically excite the
15 riser and cause the pipe to fail prematurely. Strong currents increase the amount of vortex induced vibration (VIV).

Presently, there are a number of commercially available vortex induced vibration suppressors. One such product is available from Mark Tool Company of Lafayette, Louisiana.
20 Another commercially available vortex induced vibration suppressor is available from CRP Marine Products of England. Another commercially available vortex induced vibration suppressor or "strake" system is being commercialized by Dunlaw of Aberdeen, Scotland. Another device that is
25 commercially available and that suppresses vortex induced vibration is sold under the mark Uraduct® VIV.

One of the problems of placing a vortex induced vibration suppressor on an oilfield riser pipe such as the riser associated with a deep water oil and gas well drilling or
30 production platform is the problem of installing or placing the strake. This problem can be solved by using an underwater diver or divers. However, such a procedure is dangerous and very costly. Some VIV devices have multiple parts that limit

overall structural strength.

BRIEF SUMMARY OF THE INVENTION

The present invention provides an improved method and apparatus for solving the problem of vortex induced vibration
5 by providing a suppression apparatus of improved construction that features an elongated body of flexible polymeric material (for example polyurethane), the body having a wall surrounding a continuous, open-ended bore.

A plurality of helical vanes are provided on the body,
10 extending along the length thereof.

A longitudinal slot extends through the wall, enabling the body to be separated to afford access to the bore (such as during placement on a pipe or riser). In another embodiment, the apparatus can be cast in place on a pipe joint
15 or cast as a one piece strake that is slipped over a pipe and then glued, eliminating the slot and bolted connection.

In the preferred embodiment, the entire elongated body and vanes are of a integrally formed, preferably cast or molded polymeric material (for example, polyurethane). This
20 construction enables the entire elongated body to be flexed as portions of the body are separated apart at the slot.

In the preferred embodiment, the slot extends along one of the vanes, separating the vane into first and second vane portions, each having a surface that abuts a corresponding
25 surface of the other vane portion upon assembly.

The slot is preferably a helically shaped slot that tracks the path of the vane.

A removable connection can hold the body together at the slot. In the preferred embodiment, this removable connection
30 is in the nature of a bolted connection or connections that bolt first and second vane portions together.

This removable connection is preferably comprised of a plurality of regularly spaced apart, bolted connections.

In the preferred embodiment, the slot separates one of the vanes into first and second longitudinally extending vane sections, each having a flat mating surface (or offset for aiding alignment), wherein the flat mating surfaces are
5 engaged, the bolted connections can be perfected to hold them together.

In another embodiment, the present invention provides an improved vortex induced vibration suppression apparatus that features the elongated body and helical vanes with a
10 longitudinal slot that extends through the wall at a vane for enabling the body to be separated to afford access to the bore.

In an alternate embodiment, a spacer is removably attachable to the body, the spacer including a rounded outer
15 surface that enable the spacer and body to be rolled such as during handling upon the deck of a ship or barge. The spacer provides an elongated bore that is shaped to fit the body and its helical vanes.

The present invention provides an improved method of
20 installing a riser having one or more vortex induced vibration suppression devices thereon. The method includes first making up the riser section on a pipeline lay barge that provides a stinger. The vortex induced vibration device or devices is attached to the pipeline on the lay barge. In this fashion,
25 the riser and attached vortex induced vibration suppression devices can be lowered to the seabed by first passing the riser and attached vortex induced vibration suppression devices over the stinger part of the barge. With the present invention, the improved construction of the vortex induced
30 vibration suppression device enables the apparatus to be lowered over a stinger of a lay barge to the ocean floor.

BRIEF DESCRIPTION OF THE DRAWINGS

For a further understanding of the nature, objects, and

advantages of the present invention, reference should be had to the following detailed description, read in conjunction with the following drawings, wherein like reference numerals denote like elements and wherein:

5 Figure 1 is a side view of the preferred embodiment of the apparatus of the present invention;

Figure 2 is an end view of the preferred embodiment of the apparatus of the present invention taken along lines 2-2 of Figure 1;

10 Figure 3 is an end view of the preferred embodiment of the apparatus of the present invention and showing part of the method of the present invention wherein the vortex induced vibration suppression apparatus is being separated at its slot for installation;

15 Figure 4 is another end view illustrating the preferred embodiment of the apparatus of the present invention and showing the optional method step of applying an adhesive to the inside wall surface thereof and is part of the method of the present invention;

20 Figure 5 is a perspective view of the preferred embodiment of the apparatus of the present invention and illustrating one of the method steps of the present invention, namely the application of the vortex induced vibration suppression device to a riser;

25 Figure 6 is a perspective view showing the preferred embodiment of the apparatus of the present invention and illustrating part of the method of the present invention, namely the application of fasteners such as bolted connections to the apparatus after placement upon a riser;

30 Figures 7A-7B are side views of the preferred embodiment of the apparatus of the present invention showing the device after placement upon a riser;

Figure 8 is an elevation schematic view showing the

method of the present invention, namely the step of lowering the riser and attached vortex induced vibration suppression devices from a pipeline lay barge to the ocean floor;

Figure 9 is an elevation, schematic view of the preferred embodiment of the apparatus of the present invention illustrating the method of the present invention, showing several vortex induced vibration suppression devices mounted to a riser and showing a riser and connected devices positioned next to an offshore oil and gas well drilling/production platform;

Figure 10 is an exploded view of the preferred embodiment of the apparatus of the present invention; and

Figure 11 is an end view of the preferred embodiment of the apparatus of the present invention;

Figure 12 is a front, perspective view of a second and preferred embodiment of the apparatus of the present invention;

Figure 13 is a schematic view of the second embodiment of the apparatus of the present invention and showing the method of the present invention wherein the initial step is illustrated of wrapping the strake body around a pipeline section;

Figure 14 is a schematic end view showing another of the steps of the method of the present invention;

Figure 15 is a schematic end view showing another of the steps of the method of the present invention; and

Figure 16 is a schematic, perspective view showing the second embodiment of the apparatus of the present invention after attachment to a pipeline section and resting upon the rollers of a stinger on a pipeline laying vessel.

DETAILED DESCRIPTION OF THE INVENTION

Figures 1-11 show the preferred embodiment of the apparatus of the present invention, designated generally by

the numeral 10.

Vortex induced vibration suppression device 10 includes body 11 having a central longitudinal open ended bore 12 and end portions 13, 14.

5 Body 11 is preferably a one piece, molded or cast flexible body that is preferably of a polymeric material such as polyurethane. A plurality of helical vanes 15, 16, 17 extend from the wall 30 of body 11 and are preferably integral therewith. A longitudinally extending slot can be optionally
10 formed by mating surfaces 20, 21 of vane sections 18, 19 as shown in Figures 1-4. Otherwise, body 11 does not have a slot but is a one piece integral member that can be installed by slipping it over an end of a joint of pipe. It can also be case in place on a joint of pipe.

15 A hinge area 29 is provided generally opposite vane sections 18, 19 and the respective mating surfaces 20, 21. A user can spread apart the vane sections 18, 19 as shown by arrows 34 in Figure 3 for enabling a technician 25 to apply an adhesive 23 using a desired tool or implement such as
20 dispenser 24 to the inside surface 22 of body 11. During this procedure, a spreader bar 26 can be used to hold the vane sections 18, 19 apart as shown in Figures 3-5.

 The vane section 18 provides a plurality of longitudinally extending, spaced apart openings 27. The
25 openings 27 align with a corresponding plurality of longitudinally extending, spaced apart openings 28 through vane section 19. After an adhesive is applied to inside surface 22 of wall 30 of body 11, the body 11 can be placed upon a pipeline riser section 32 as indicated schematically
30 by arrow 35 in Figure 5. Arrow 36 in Figure 5 schematically illustrates the removal of spreader bars 26 once the body 11 is placed upon riser section 32.

 When properly assembled upon a pipeline riser section 32

as shown in Figure 6, the wall 30 outer surface 31 provides a smooth contour that is substantially similar in curvature to the outside surface of the pipeline riser section 32.

The adhesive 23 is designed to form a good bond between
5 body 11 and the outside surface 33 of pipeline riser section 32. A plurality of bolted connections 40 can be used to bolt vane sections 18, 19 together to further secure each body 11 to its pipeline riser section 32. In Figure 6, each bolted connection 40 includes bolt 37, nut 38 and a plurality of
10 washers 39 if desired.

The method the present invention is further illustrated in Figures 8-9 and 10-11. In Figure 8, a pipeline lay barge 41 is shown having a deck 42 upon which is stacked a plurality of pipe joints 43. The pipeline lay barge 41 also includes a
15 welding area 44 that enables a plurality of the pipe joints 43 to be welded together end-to-end as known in the art. A stinger 45 is also provided with lay barge 41. Such a lay barge 41 and stinger 45 are well known in the art.

According to the method of the present invention, the
20 vortex induced vibration suppression devices 10 of the present invention are assembled to the welded pipeline riser 47 before the riser 47 is lowered to the seabed 50 via stinger 45. In Figure 8, the arrow 46 schematically illustrates a riser 47 that is fitted with a plurality of vortex induced vibration
25 suppression devices 10. The combination of pipeline riser 47 and its vortex induced vibration suppression devices 10 or "strakes" are lowered over the stinger 45 as indicated by arrow 46. To further schematically illustrate the method of the present invention, the surrounding ocean 49 is also shown
30 with water surface 48 and seabed 50.

In Figure 9, an offshore platform 53 is shown. It should be understood that platform 53 can be an offshore oil and gas well drilling and/or production platform. Such a platform 53

is typically supported with support 52 that can be a semisubmersible, TLP or jacket type foundation or any other marine platform support known in the art. In Figure 9, the numeral 51 schematically indicates the entire marine structure
5 that includes support 52 and platform 53.

In Figures 10 and 11, a plurality of spacers 54 are shown that are attachable to one of the bodies 11. As shown in Figures 10 and 11, three spacers 54 can be added to a single body 11 in order to transform it into a cylindrically shaped
10 member that can be easily rolled for ease of transport and ease of installation. Each spacer 54 has end portions 55, 56. Each spacer has a concave surface 57 and a convex surface 58. The concave surfaces 57 are shaped to conform to the outside surface 31 of body 11 in between two adjacent vanes such as
15 15, 16 or 16, 17. Each spacer 54 provides side beveled edges 59, 60 that fit next to a vane 15, 16, 17 as shown in Figure 10.

In Figure 11, three spacers 54 are shown attached to a single body 11. A plurality of straps (not shown) can be used
20 to encircle the combination of spacers 54 and body 11 to thereby secure the spacers 54 to the body 11 until they are to be removed. Typically, this removal can be accomplished just before the body 11 is to be transported to an end user or job site.

25 Optionally, the polymer (eg. polyurethane) for either embodiment has a copper nickel particulate dust contained therein. This mixture of polymer and copper nickel particulate dust enhances antifouling capability of the strake.

Figures 12-16 show a second embodiment of the apparatus
30 of the present invention, designated generally by the numeral 61 in figures 12 and 16.

Vortex induced to vibration suppression device 61 includes a polymeric body 62 that can be of polyurethane for

example. The body 62 has a bore 63 that is opened ended. Body 62 provides opposing end portions 64, 65.

The body 62 is provided with a plurality of helical vanes 66, 67, 68. The body 62 also has a thin walled section 69, 5 the vanes 66, 67, 68 extending radially from the thin walled section 69. Further, the helical vanes 66, 67, 68 are circumferentially spaced apart as shown in figures 12-16.

A helical slot 70 is provided that can be, for example, in between vanes 66 and 68 as shown in figures 12, 13 and 16. 10 The slot 70 enables the body 62 to be mounted on a pipeline section 83 by spreading apart mating edges 71, 72 as shown in figure 13 and then wrapping the body 12 about the pipe section 83 as shown in figures 13, 14 and 15.

The body 62 has an inside surface 73 that is sized and 15 shaped to fit the outside surface 84 of pipeline section 83.

In order to assemble body 62 to a pipeline section 83, each vane is provided with openings that are positioned next to thin walled section 69 as shown in figures 12-16. The openings include opening 78 through vane 66, opening 79 20 through vane 77, and opening 80 through vane 68. A plurality of openings are provided for each of the vanes 66, 67, 68 as shown in figure 16. The openings 78, 79 and 80 are longitudinally spaced for each vane 66, 67, 68 as shown in figure 16.

25 In order to assemble the body 62 to a section of pipeline 83, a plurality of bands or straps 74 are encircled through the various openings 78, 79, 80 and secured as shown on figures 14 and 15. Each strap 74 provides a buckle 75 that can be used to secure the strap or band 74 once it is 30 tightened using a commercially available tensioning tool 81. Strap 74, its buckle 75 and tensioning tool 81 are all commercially available.

In figure 14, arrow 85 schematically illustrates the

insertion of band 74 through an opening 78 of a vane 66. In figure 14, the band 74 has already been inserted through opening 79 of vane 67 and opening 80 of vane 68. In figure 15, the band or strap 74 has been inserted through each of the 5 openings 78, 79 and 80 and is being tightened using the tensioning tool 81. In figure 16, several of the bands 74 have been attached to body 62 at openings 78, 79 and 80 and have been tightened to show the completed position of each band 74 with respect to the body 62. The vortex induced 10 vibration suppression device 10, 61 of the present invention can be used on any diameter pipe.

PARTS LIST

The following is a list of suitable parts and materials for the various elements of the preferred embodiment of the 15 present invention.

	10	vortex induced vibration suppression device
	11	body
	12	bore
20	13	end portion
	14	end portion
	15	helical vane
	16	helical vane
	17	helical vane
25	18	vane section
	19	vane section
	20	mating surface
	21	mating surface
	22	inside surface
30	23	adhesive
	24	dispenser
	25	technician
	26	spreader bar

	27	opening
	28	opening
	29	hinge area
	30	wall
5	31	outer surface
	32	pipeline riser section
	33	outer surface
	34	arrow
	35	arrow
10	36	arrow
	37	bolt
	38	nut
	39	washer
	40	bolted connection
15	41	pipeline lay barge
	42	deck
	43	pipe joint
	44	welding area
	45	stinger
20	46	arrow
	47	welded riser
	48	water surface
	49	ocean
	50	seabed
25	51	marine structure
	52	support
	53	drilling/production platform
	54	spacer
	55	end portion
30	56	end portion
	57	concave surface
	58	convex surface
	59	beveled edge